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MAN-MADE DESERTS

by

Dr. W. C. Lowdermilk

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The history of civilizations is a record of struggles against the progressive desiccation of civilized lands. The more ancient the civilization, the drier and more wasted, usually, is the supporting country. In fact, so devastating seems the occupation of man that, with a few striking exceptions, a desert or near-desert condition is often associated with his long habitation of a region. Two major factors are believed to account for the growth of man-made deserts. In the first place, semi-arid to semi-humid regions proved the most favorable sites for the early development of human culture. Such areas, however, stand in a condition of delicate ecological balance between humid and true desert climates. Comparatively slight disturbances of the coverage of vegetation and soils, such as are brought about by human occupation for grazing and cultivation, are sufficient to extend the borders of the desert far beyond the natural true desert into more humid climates.

In the second place, processes of soil erosion are accelerated by the exposure of soil surfaces hitherto protected by complete mantles of vegetation, whether grass or forest, by heavy grazing and cultivation. It is only within the past decade that experimental studies of these processes have been made. So enormous have been the differences in soil wastage and superficial run-off of rain waters from bared sloping lands, as compared with similar surfaces protected by a complete coverage of vegetation, that new light is thrown on the problem of the decadence of former civilizations. Aside from other important factors the history of civilizations may be interpreted in terms of soil erosion, so direct is the relation between the productive condition of soils and the prosperity of a people. The operation of mankind's exploitative and destructive activities is often decisive in zones of delicate balance between soil formation and destruction, between rain absorption and rapid run-off.

Recently the archaeologists have turned back the pages of history, not merely centuries, but thousands of years. Their post-mortems on buried civilizations suggest that it has been the hand of man, more than climatic change, which has reduced once rich and populous regions to desolation and poverty. After a long struggle, a civilization either died or its people migrated to more productive regions. Many ancient civilizations, once revelling in a golden age of prosperity, are crumbling in ruins or lie buried in sands and debris, largely caused by the destructive treatment of the lands on which they were dependent for sustenance. If modern peoples are to escape a similar fate by man-induced impoverishment and the desiccation of their lands, it would seem well to take a measure of these destructive processes and forces, and by intelligent land planning and land use provide for the sustained productivity of agricultural lands and the protection of grass lands and forests for food, textiles, raw materials and continued water supply.

It is evident that climatic changes have occurred in the past and are still in progress. Such changes follow the pace of land movements and are comparatively slow in terms of human history. Superimposed upon them there may be a rapid growth of human populations and their activity, as well as that of their herds, which can produce increased desiccation equivalent in effect to changes of climate. It becomes important to discover how far human occupation is rendering the earth less inhabitable and at the same time to discover means by which such processes of deterioration may be held in check and productivity sustained. It is possible for man and his animals to render regions uninhabitable, especially in zones of delicate ecological balance between humid and true desert climates. Man-made deserts may extend from semi-arid climates to humid climates, under certain conditions. In the light of this conception, of man-induced desiccation, it is in place to examine what is now known about the results of human occupation, in the way of increasing aridity due to destruction of vegetative cover, and how these desert conditions are rapidly being brought about in various areas throughout the world.

New knowledge concerning desert conditions resulting from over-grazing of domestic herds, especially in periods of drought, has interesting implications. Aerial moving pictures taken by Mr. and Mrs. Martin Johnson in Africa show wild herds, numbering scores of thousands, blackening the landscape as they trot across the plains, in clouds of dust, to water holes. The landscape shows every evidence of destruction of vegetation and breakdown of surface soils, resembling the effects of over-grazing by domestic herds in America. The Westover and Enlow Expedition in Russian Turkistan during 1934 reported that water holes were usually marked by active sand dunes, due to the complete destruction of surrounding vegetation by converging herds. This suggests the possibility that in the remote past enormous wild grazing herds, during drought periods, may have so utterly destroyed vegetation as to set in motion desert-producing processes, not unlike those induced by domestic herds in the past and present.

Many students have attributed desiccation and the consequent drying up of streams to the removal of forests. That is only part of the story. The great enemy of the human race is soil erosion, which has been associated with the habitations of man since before the dawn history. It is no new land disease, but has only recently been diagnosed and named for what it is. The removal of vegetation, whether grass, brush, or forest, exposes soils to the dash of rain or the blast of wind, against which they had been protected for thousands of years. Topsoils blow away or wash away, or both. Unprotected sloping lands are usually bared to hard and tight subsoils, which drain off the water as from a tiled roof. The perennial streams, deprived of their reservoirs of supply, dry up except in rainy seasons, when they become torrential floods and sweep boulders and debris down the slopes to deposit them on otherwise fertile lowlands. Then starving wild or domestic herds clean the devastated areas of all palatable vegetation, only to reduce the effectiveness of beneficent rains and to accentuate aridity. This is the cycle which, whether ancient or modern, has transformed vast areas of good lands into extensive arid bad lands, or actual desert. With the loss of vegetation and soils, which had developed interpendently for unknown ages, near-desert to desert conditions have been brought about in the old inhabited portions of the world.

According to archaeologists the Sahara, the Central Asian deserts, arid parts of Palestine, Mesopotamia and the Gobi and North China were once teeming with human life. Traditions of peoples descended from ancient cultures tell of immigration to their present habitation from what are now desert regions of Central Asia. The origin of European peoples was in the East. The Hindus came from the north, the Chinese from the west. Yet this land from which they came is today an immense desert where only very limited regions are still able to nourish a scanty population. Sir Aurel Stein's discoveries of sand-buried ruins in Central Asia revealed numerous towns a square mile or more in size, in a region now depopulated. There were ruins of cities, castles, aqueducts, reservoirs and all the evidences of lost cultures, of vanished populations. Gibbon declared that 500 cities once flourished in what are now the dry depopulated plains of Asia Minor. The recently discovered ruin of Tepe Gawra in northern Mesopotamia is claimed to be the oldest remaining town in the world. The ruins show that in B. C. 3700 this was a well planned city, which must have represented long ages of prior development. The peninsula of Arabia contained an enormous population, called Sealand, which at times annoyed Babylon from B. C. 2500 to 616. Now, a few fierce nomadic Bedouins, remnants of former cultures, fight for existence over every drop of water and every sign of vegetation. The great Sahara desert has recently revealed monuments, ruins of cities, temples, implements and unearthed cut trees. Campalion, the famous Egyptologist, says of it "and so the stonishing fact downs upon us that this desert was once a region of groves and fountains and the abode of happy millions." The very gradual climatic changes due to the present age of retreating ice do not appear sufficient to account for the excessively rapid desiccation of the vast areas known to have sustained at one time enormous populations.

We have a written record of encroaching deserts. When Zenobia was overthrown by the Romans under Aurelian, its capital, Palmyra, was the metropolis of a mighty empire. Now the sands of the Sahara almost hide the ruins of that stupendous city of marble and gold. As late as the rise of Mohammed Tripoli, on the north coast of Africa, had a population of six million. It was then clothed with vineyards, orchards and forests. It is now bare of vegetation. The streams are dried up and the population reduced to about forty-five thousand. Archaeologists now claim to have discovered, under shifting sands, the capital of the rich kingdom of the Queen of Sheba. Dr. Breasted, the flying archaeologist, attempted to take twelve thousand feet of film over ancient ruins now being excavated. He encountered fierce and choking dust storms making it necessary to rise to 12,000 feet in order to breathe clean air. These dust blizzards are an exhibition of wind erosion at work on denuded areas. Such dust storms occurred on a stupendous scale for the first time in western United States in 1934 and 1935.

The aerial photographs taken by the Shipley Johnson expedition in Peru portray a similar condition. On the west coast of South America, where the oldest known civilization developed on the western continent, the entire region photographed was shown to be in a treeless, barren, denuded condition. Ancient walls were in some instances entirely drifted over with sand, so that only from the air could they be recognized as huge

mute reminders of former civilizations. The native population of today seemed very poor specimens of the flourishing civilization and culture of the past, before man and erosion had completed the destruction of vegetation.

If man has turned fertile lands into barren, semi-arid wastes or actual desert, what are the diabolic processes? Soil wastage or erosion, caused by the destruction of vegetation, is not the geologic erosion which with the leisure of land uplift or subsidence has carved out canyons, rounded off hills and filled in alluvial valleys. In this slow process, the balance between vegetation and soil formation and erosion is undisturbed, and soils are formed as rapidly as they are washed away. Geologic erosion does not proceed faster than soils are formed under a protective cover of vegetation. Thus we may use this geologic norm of erosion, responsive to local conditions, as a basis for the measurement of what may be called "accelerated or man-induced erosion," in which soils are washed away far in excess of possible soil formation.

This accelerated erosion is the direct result of destroying the protective vegetable covering of soils, whether by burning forest or grasslands, by over-grazing, or by clearing and cultivation. Erosion of an accelerated order then begins. The fertile topsoil is rapidly washed away, or blown off. Erosion sorts soils with machine precision. The fine and fertile particles are carried far away, either by wind or by flowing water, leaving the coarse and less fertile materials dumped near by. Water erosion begins with little rivulets, which grow into gullies and tear away the fertile topsoil. Denuded areas may soon be washed away to intractable subsoil. Percolation is reduced to an important degree, and the concentrated rain waters rush off the land as if from a tiled roof, carrying rocks and debris with them. These are strewn on the level alluvial bottom lands, impairing or destroying their productivity. Gullies drain out the ground moisture, excavate the soil, and fasten themselves onto a countryside like tentacles reaching out in all directions. Sheet erosion is less spectacular than wind or gully erosion but is perhaps more dangerous, because it works so stealthily, skimming off the fine-textured soil from plowed fields after each shower. Yearly these little rivulets are plowed over and the farmer forgets his loss until finally his fields change to the color of the infertile subsoil, or "grow rocks." Results from one of many experiments at erosion experiment stations indicate that it would require 12,000 years to wash away 12 inches of surface soil on the Marshall Silt loam in the Mississippi Valley (Missouri), when covered with alfalfa, or more than 100,000 years when covered by native sod; whereas it would require only 29 to 36 years to wash away one foot of soil when cultivated to corn on an eight percent slope.

The destructive forces of erosion are not confined to fields robbed of fertility or lowlands ruined with rocks and debris. Silt-bearing streams become choked and overflow, with inestimable loss of life and property. Irrigation systems and reservoirs are impounded with troublesome silt which destroys the storage of irrigation water. Furthermore, the denuded hill and mountain slopes store less water than was possible in their former thick, humus, spongy soils, and streams become dry rocky beds and dry seasons, when they are most needed, and roaring destructive torrents in rainy periods.

A few years ago I conducted a number of expeditions into Northwest China, the "cradle of Chinese civilization." Tradition of early times said the Chinese had come from the west. The forebears of the race of Han settled in the alluvial plains of the Yellow River. The largest of these, above the delta, is the lower valley of the Wei River, where Ch'angan was the capital city. The Wei Wei plain, in Shensi, where the Chinese civilization first came to flower, the seat of the golden age of China, is now filled with the ruins of a former opulence and magnificence. The slopes of the surrounding region are riddled with gargantuan gullies, which promptly drain away most of the usual rainfall. The aspect of the drainage areas is one of an approaching desert impoverishment. Erosion of soils from out of the watersheds has put out of commission an ancient irrigation system and left the former populous plain sparsely peopled and subject to drought famines once or more in a decade. The deterioration of this region might well be assumed to have been due to adverse climatic change, if it were not for the temple forests now growing without artificial aid about Buddhist temples.

My first realization of the man-made destruction of Northwest China was a walled city in the upper Fen River valley, almost empty, with deserted homes and a dried up stream bed outside the city gate. Detailed field studies of the surrounding mountains and lands revealed the whole tragic story of accelerated or man-induced erosion. The first inhabitants had found the mountains heavily forested, the valleys fertile and well watered with perennial streams. They built their city and prospered. As the population increased, they destroyed the forests, primarily to cultivate the rich humus soils, and bench terracing was not used to safeguard the soils. As the topsoil washed off the farmers went higher, clearing the lands until the tops of the mountains were reached.

Soil erosion progressively reduced productivity until cultivation was abandoned. Sheep and goats were turned out on the wasting fields to complete the destruction. Gullies started which swept boulders and debris down onto the fertile lowlands. The streams had gradually dried up. Thus the forests were gone; the streams were gone; the soils were gone; and when the soils go, man either starves or migrates to other regions. A land that supported millions with plenty now meagerly supports a small population frequently ravaged by famines. It is roughly estimated that an average of at least twelve inches of topsoil have, by this suicidal agricultural process, been washed off of hundreds of millions of acres of the watersheds of North China, by this kind of accelerated erosion, above the normal geologic erosion during recent times.

The decadence of North China has often been attributed to adverse climatic changes. Conclusions from my own studies, reported elsewhere, indicate that man-induced soil erosion and its consequences in increased run-off would account for such decadence without climatic change. I have frequently found, in North China, temple forests like green emeralds in an ugly setting of denuded mountains. These forests had been protected throughout the centuries from the ax and the plow, and the teeth and hoofs of sheep and goats. In their cool and refreshing shade, the trees were reproducing naturally within the present prevailing climate and rainfall. These forests as samples are evidence enough that the present climate would support such

cover over similar regions. Thus loss of vegetation in North China is not due to increasing aridity; but increasing desiccation has followed the loss of soils, and resulting lack of conservation of moisture.

Erosion is not confined to temperate zones, if man sets in motion soil-destroying forces. The great Mayan civilization, undoubtedly one of the highest of prehistoric America, was destroyed by erosion. Dr. C. Wythe Cooke of the United States Geological Survey declares that "the Maya civilization choked itself to death with mud washed from its own hillside corn patches. The Maya cities were built near small lakes which are now silted up with sticky clay soil. These lakes were used for transportation. On the nearby hills, the farmers grew their corn. With continued cultivation of the slopes, the soils washed off; transportation on the lakes was made impossible and they were then forced to migrate as is recorded in history."

A man-made desert is not as fantastic as it sounds. At least we may call deserts the regions of aridity and desolation where the recklessness, ignorance of hunger-drive of man have supplemented the forces of wind and water erosion in destroying vegetation and soils, resulting in regional suicide. Many nations are now awakening to the menace of the prodigal wastage of soil erosion. South Africa has thus lost the productivity of millions of acres. France, Greece, Spain, Australia, Madagascar, Italy and the United States, all show the destroying forces of erosion. In sharp contrast Germany and Japan, particularly, have provided for prevention and control of soil erosion and for the preservation of forest and grass resources.

America has been developing desiccated and unproductive lands more rapidly than probably ever before occurred. About three hundred years ago the colonists entered this continent of vast untouched resources with a burst of energy and began an unexampled period of exploitation. There were reservoirs of population in Europe which supplied millions of vigorous and daring people to clear away the forests and cultivate the soil at an astonishing rate, in their westward march of agricultural occupation. It was a rapid advance over a wide front by farmers and stockmen with their plows and herds, until today all frontiers have been pushed westward to the Pacific. Lands had been free and the supply seemed inexhaustible. Farmers exploited the best of a farm and then abandoned it to a race between erosion and the healing agencies of nature, and moved on west to clear new lands.

During the Presidency of Theodore Roosevelt, forests of the United States were being slaughtered at an appalling rate. Gifford Pinchot showed the President a painting, done in the fifteenth century, of a beautiful, populous and prosperous well-watered valley at the foot of forested mountains in North China, and with it a photograph of the same valley, taken about 1900. The photograph showed the mountains treeless, glaring and sterile; the stream bed empty and dry; boulders and rocks from the mountains covering the fertile valley lands. The depopulated city had fallen in ruins. The President illustrated his message to Congress with these pictures and caused the establishment of the U. S. Forest Service for the protection of forest lands.

In their brief destructive period of occupancy, the American people on the North American continent have, by the same methods of suicidal use of lands, utterly destroyed and abandoned, through loss of vegetation and soil erosion, 51,000,000 acres of good lands; and 200,000,000 acres more are in the clutches of erosion. Now, in a land of so-called inexhaustible land resources, all good lands are largely under cultivation and millions of farmers are eking out a privation existence on farms whose topsoils have washed away. No longer is it possible to move on to new lands to the west. The day has come for the conservation of remaining soil resources.

To the United States, doubtless, goes the speed record in time and extent, for man-made desert conditions. The dust storms of the old world, long occupied by man, have appeared in the new world--and for the same reasons. Great dust clouds obscuring the sun at midday swept out of the western plains eastward to the Atlantic seaboard for the first time in May 1934. Over large areas, in the central and southwest plains, every living thing choked in the dust-filled atmosphere. Pasture vegetation was coated with dust and made inedible for stock. Fields were turned into sand dunes. It has been a tragic experience, but it is the price that a whole nation is paying for the rapid exploitation of its prairie grazing lands about the close of the war. For centuries, nature had anchored these soils with a thick sod of buffalo or native grasses. Then came the war boom and high prices, which stimulated the plowing up of millions of acres of the western grass lands. Grazing lands were attacked with tractor-drawn plows. The rich humus soils first yielded abundant crops. Rains were plentiful. The same crops were planted year after year.

Then came the drought. The soil-binding quality of the humus had been depleted by continuous cropping. The stubble of poor, unharvested crops was pastured by livestock. The ground was pulverized by their hoofs. The usual strong winds began to blow in the spring. They were dry, and there was no vegetation nor roots to anchor the soils, which were blown aloft in the upper wind currents to form gigantic dust clouds. The machine-like sorting process of wind erosion began. Fine and fertile particles were blown to parts unknown and the heavy material was left behind as drifts or hummocks forming sand dunes, some of them twenty feet high. Since May 1934 wind erosion, set in motion by man-made forces, has transformed 5,000,000 acres of formerly good land into waste areas and great stretches of sand dunes. More than 60,000,000 acres more are in the process of wind erosion destruction by the same cause and will follow the desert condition of the 5,000,000 destroyed acres, unless adequate control methods are undertaken.

We boast of a modern civilization and its progress, but we have been following suicidal methods in treatment of soil resources. With high-powered implements we have been rapidly destroying the vegetation and forests, with resulting loss of productive soils and increasing desiccation. Whether ancient or modern, destruction of vegetation on sloping lands, by whatever cause, exposes fertile soils to wind and water erosion so that soils are destroyed greatly in excess of soil formation, until complete destruction of fertility is accomplished. The capacity of humus soils as reservoirs to conserve rain and snow waters is thus reduced, so that springs and streams dry up. With percolation much reduced on denuded slopes, rain waters concentrate to form destructive gullies, which further destroy

land utility. An old writer asserts that "the skin of the animal is not more necessary to its wellbeing than is the vegetative cover of the earth essential to the proper condition of the soil."

But it is not necessary for mankind to destroy the good earth upon which he is dependent for sustenance. Some primitive peoples have discovered means of conserving soils. Ideas of conservation on a national scale, however, have been conceived only in recent times. Erosion can be checked and it can be controlled. The description of erosion control methods is beyond the scope of this paper. It seems clear that man and his animals may extend desert conditions, by processes of man-induced desiccation, into regions formerly capable of supporting large populations. Climate does change, but not at the comparatively rapid rate of the decadence of vast areas of habitable regions. Experimental studies within the past two decades in the character and degree of acceleration of erosion, above the normal rates of geologic processes, have given a better understanding of how deserts may be man-made. With this understanding there may be worked out and put into effect measures adequate to the conservation of soil resources and with them moisture, and therewith a restoration of vegetation, suitable crops, and grass and forests The lands of the earth are occupied; frontiers of new lands have disappeared. The only new frontier that appears is underfoot, in the maintenance of productivity of lands now occupied.

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